

# AVO SWG: cosmology

- **Geometry, LSS and early universe:**
  - **Angular and luminosity distances:** SNIa, cosmic shear, CMB
  - **power spectrum:** amplitude, spectral index, running spectral index, growth rate: clustering of galaxies (z survey), cosmic shear
  - **topology:** CMB anisotropy
- **Extragalactic medium and history of building blocks:**
  - **re-ionisation:** survey of high-z QSOs , CMB
  - **LSS and super clusters of galaxies:** M/L; early vs late type contribution to mass and light, biasing linearity, stochasticity
  - **Clusters of galaxies:** coupling X-ray, SZ, WL, redshifts: number density as function of redshift, mass function, mass profile
  - **Star formation and chemical history**
  - **Morphological type formation history**
- **Fundamental physics:**
  - **Large scale gravity:** weak lensing
  - **Time variation of fundamental constant:** QSOs
  - **Dark energy (topic 1):** SNIa, cosmic shear, CMB

# Possible SRMs

- cosmic shear (to measure  $w$ )
- build-up of black holes
  - high- $z$  QSOs
- galaxy clusters
  - $\Omega_M$ , dark matter, LSS, power spectrum, SZ, correlation with CMB (ISW)
  - detection through multi-spectral comparisons
  - morphology-density relation
- look for rare objects
  - SEDs, search multi-dimensional parameter space

# Possible SRMs (cont.)

- look for objects with parameters not fitting the known
  - SEDs, search multi-dimensional parameter space
- build-up of stellar mass with cosmic time
  - multi-wavelength, multiple surveys, modelling
- chemical evolution over cosmic time
  - star light, QSO absorption
- correlation of CMB, radio and optical/NIR galaxy surveys
- DM-haloes
  - galaxy-galaxy lensing
- epoch of re-ionisation

# Coming datasets

- APEX, ALMA (Southern), SCUBA-2
- AMI, AMOEBA, etc.
- LOFAR (Northern)
- Pan-Stars (2008/9), LSST (2011), JDEM/SNAP
- Astro-F (IR survey)
- UKIDSS, VISTA/VST
- Herschel
- Planck
- SWIFT
- GLAST
- eMerlin, eVLA

# Ongoing surveys

- SDSS, 2MASS, Combo-17(+4), HDFs, UDF, CDF-S
- 2dF, 6dF
- XMM, Chandra
  - XMM-LSS, XMM serendipitous sky survey
- CFHT-LS
- Spitzer
  - SWIRE, GOODS
- COSMOS, GEMS
- GALEX
- 22 GHz (ATCA)
- WMAP, COBE
- FIRST, NVSS, SUMSS, WENSS

# Existing (imaging) archive

- Radio
  - NRAO, Merlin, E-VLBI, ATCA, JCMT, UMRAO
- IR
  - Spitzer, ISO, IRAS
- Optical
  - ESO, UK-ADC, CFHT, NOAO, Gemini, AAT, HST, WFI-Astrowise
- UV
  - Galex, IUE
- everything
  - MAST

# Weak shear

- cosmological parameters (especially  $\Omega_\Lambda$  and  $w$ )
- determine LSS
  - need large area
  - photometric redshifts
  - image quality
- COSMOS, CFHT-LS, JDEM/SNAP
- Yannick Mellier knows all about this ...

# Build-up of black holes

- census of black holes as a function of  $z$ 
  - QSO 1 and QSO 2 (Padovani)
    - correlating radio, X-ray and optical/NIR point sources
    - need field of view
      - GOODS only good for  $z > 3$
    - photometric redshifts
    - SED “identifications”
  - high- $z$  QSOs (McMahon)
    - sky area, Lyman-break (“SED”)
    - XMM serendipitous survey and FIRST/SUMSS

# Galaxy clusters

- $\Omega_M$ ,  $\sigma_8$ , dark matter, LSS, power spectrum, SZ, correlation with CMB (ISW)

(Maccacaro, Hopp, Cimatti, Voges, Rosati)

– detection through multi-spectral comparisons

- red sequence in optical/NIR
- diffuse X-rays
- galaxy clustering
- SZ signal
- lensing signal
- (add spectral search)

– Large-scale galaxy evolution (Valentijn)

- morphology-density relation
- sites of morphological transitions
- automatic morphological classification
- statistics: identification of LSS and outside

# Rare or unknown objects

(Leahy, Valentijn, Leibundgut)

- search multi-dimensional parameter space
  - time-variability
  - SEDs, ‘two-colour’ diagrams
  - beware of false-positives (uncertainties!)

# Build-up of stellar mass with cosmic time

- SEDs (Cimatti)
  - optical, NIR (UKIDSS/VISTA), infrared (Spitzer-SWIRE/GOODS)
  - fitting to population synthesis models (e.g. GISSEL)
- Gas masses (?)
  - HI
  - DLAs and IGM

# Chemical evolution over cosmic time

- star light (Cimatti, De Young)
  - massive spectroscopy surveys (e.g. VIMOS, GALEX, SDSS, 2dF, CIRPASS, FMOS, KMOS)

# Correlation of CMB, radio/mm and optical/NIR galaxy surveys

(Banday, Leahy, da Costa)

- ‘all sky’ surveys
- Sunyaev-Zeldovich clusters (AMI, AMOEBA, Planck)
- integrated Sachs-Wolfe effect (WMAP, Planck)
- gravitational lensing of CMB polarisation (BICEP, CLOVER, etc.)

# Dark matter haloes

- galaxy-galaxy lensing (Quinn)
  - deep imaging surveys (SDSS, VST, GEMS, COSMOS)
  - stacking of galaxy images and measuring galaxy shapes (similar to weak shear → Mellier)
  - (galaxy case? – tidal streams, dwarf companions/satellites, background galaxies)

# Epoch of re-ionisation

- cross-correlate HI holes (LOFAR) with Lyman-break objects  
(Valentijn, Cimatti, Hopp)
  - redshift known from LOFAR observations
- find high- $z$  quasars (McMahon)
  - see build-up of black holes